CLAIMS

1. An electrochemical assay device with integrated amperometric flow monitoring means, characterised by:

a microfluidic system comprising at least one covered microchannel having an inlet and an outlet;

means for applying a pressure difference between the inlet and the outlet of said microfluidic system such as to generate a flow of solution within said covered microchannel; and

at least one electrode integrated in a wall portion of said microchannel;

wherein said integrated electrode is adapted to monitor the solution flow at the precise location of said integrated electrode by amperometric measurement, and wherein said integrated electrode is in addition adapted to electrochemically detect an analyte of interest during an assay.

2. The device of claim 1, wherein said solution comprises a reporter molecule for monitoring the solution flow at the precise location of said integrated electrode by amperometric measurement.

3. The device of claim 1 or 2, wherein said pressure difference is induced by gravity, namely by a difference in solution height between the inlet and the outlet of said covered microchannel.

4. The device of claim 3, wherein said microfluidic system is placed on or in a solid support which can be tilted in order to generate said difference in solution height between the inlet and the outlet of said covered microchannel.

5. The device of claim 1 or 2, wherein said means for applying a pressure difference comprises an external actuator.

6. The device of claim 5, wherein said external actuator comprises means for imposing a pressure on the fluid present at the inlet and/or within said microchannel, thereby generating a solution flow within said microfluidic system.

7. The device of claim 5, wherein said external actuator comprises means for imposing an underpressure at the outlet of said microchannel, thereby enabling aspiration of said solution within said microchannel.

8. The device of claim 2, wherein said reporter molecule is any one of ferrocene, ferrocene carboxylic acid, hexacyanoferrate and oxygen.

9. The device of any preceding claim, wherein said microfluidic system comprises a material selected from polymer, glass, ceramic, another flow tied material and a combination thereof.

10. The device of any preceding claim, wherein said microfluidic system comprises a multi-layer body.

11. The device of any preceding claim, wherein said microfluidic system comprises a light-transparent material.

12. The device of any preceding claim, wherein said microfluidic system is fabricated by a process selected from plasma etching, laser photoablation, embossing, injection molding, UV-liga, polymer casting, silicon etching and any combination thereof.

13. The device of any preceding claim, wherein said integrated electrode has a precise size and location in said microfluidic system.

14. The device of any preceding claim, wherein said microfluidic system comprises a network of microchannels.

15. The device of any preceding claim, wherein said microchannel is covered by one of a lamination, a sealing plate and a plate fixed over said microchannel and maintained by external pressure.

16. The device of any preceding claim, wherein said at least one electrode is composed of a conductive surface selected from a metal surface, carbon and a liquid/liquid interface.

17. The device of any preceding claim, wherein said at least one integrated electrode is adapted to detect an analyte by amperometric measurement.

18. The device of any preceding claim , wherein said integrated electrode is adapted to simultaneously detect an analyte by electrochemistry and monitor the solution flow by amperometric measurement.

19 The device of any preceding claim, wherein the solution flow within said microchannel is continuously monitored at the precise location of said integrated electrode by amperometric measurement during all the steps of an analytical assay preceding the detection of the analyte.

20. The device of any preceding claim, wherein said covered microchannel contains a biological compound.

21. The device of claim 20, wherein said biological compound is selected from an enzyme, an antibody, an antigen, an oligonucleotide, DNA, a DNA strain or a cell.

22. The device of claim 20 or 21, wherein said biological compound is immobilized in said covered microchannel.

23. The device of any preceding claim, wherein the application of said pressure difference can be stopped.

24. The device of claim 23, wherein the stopping of the application of said pressure difference is performed by mechanically blocking one of said inlet and said outlet of said microchannel.

25. The device of claim 23, wherein the stopping of the application of said pressure difference is performed by adding a liquid immiscible with said solution to at least one of said inlet and said outlet.

26. The device of any preceding claim, wherein said flow of solution is used in an affinity sorbent assay in order to perform incubation of a solution in said microchannel and/or washing of said microchannel.

27. A method of performing an analytical assay in a microfluidic system with amperometric flow monitoring, said method comprising the steps of:

(a) providing a microfluidic system comprising at least one covered microchannel having an inlet and an outlet as well as at least one electrode integrated in a wall portion of said microchannel;

(b) depositing a solution at the inlet of said covered microchannel;

(c) applying a pressure difference between the inlet and outlet of said microchannel in order to generate a flow of said solution in said microchannel;

(d) monitoring the solution flow at the precise location of said integrated electrode by amperometric measurement; and

(e) electrochemically detecting an analyte of interest by means of said integrated electrode

28. The method of claim 27, wherein steps b) to d) are repeated in order to perform a multi-step assay.

29. The method of claim 28, wherein the solution flow is continuously monitored during a multi-step assay, except during the electrochemical detection of said analyte of interest.

30. The method of any of claims 27 to 29, wherein said pressure difference is generated by imposing an acceleration to the microfluidic system.

31. The method of claim 30, wherein said acceleration is induced by the displacement of said microfluidic system or of a solid support on or in which said microfluidic system is placed.

32. The method of claim 31, wherein said displacement consists either in rotating or in vertically lifting said microfluidic system or its solid support, so as to generate a gravitation force or, respectively, a centrifugal force.

33. The method of any one of claims 27 to 32, comprising stopping the application of said pressure difference before the electrochemical detection of said analyte of interest.

34. The method of claim 33, wherein the step of stopping the application of pressure difference comprises mechanically blocking one of said inlet and said outlet of said microchannel.

35. The method of claim 34, wherein the step of stopping the application of pressure difference comprises adding a liquid immiscible with said solution to at least one of said inlet and said outlet.

36. The method of any one of claims 27 to 35, wherein an analyte detected in the assay is directly used to monitor said solution flow by measuring an electrochemical property of said solution comprising said analyte.

37. The method of any one of claims 27 to 36, wherein an analyte is detected by amperometry at said at least one integrated electrode.

38. The method of claim 37, wherein the monitoring of the solution flow and the detection of an analyte is performed simultaneously by amperometry at said integrated electrode.

39. The method of claim 28, wherein the solution flow is continuously monitored during a multi-step assay, except during the electrochemical detection of said analyte of interest.

40. The method of any one of claims 27 to 39, for performing chemical and/or biological analysis with electrochemical detection.

41. The method of any claim 40, for performing clinical, human, in vitro and/or in vivo diagnostics.

42. The method of claim 41, for performing immunological assays.

43. The method of claim 40, for performing physico-chemical assays, toxicological assays, affinity assays, microbiological assays and/or cellular assays.

44. The method of claim 40, for performing lipophilicity measurements, analysis by ion transfer reaction, solubility assays and/or permeability tests.